Status of US ATLAS Liquid Argon (LAr) Calorimeter Phase II Upgrade Planning

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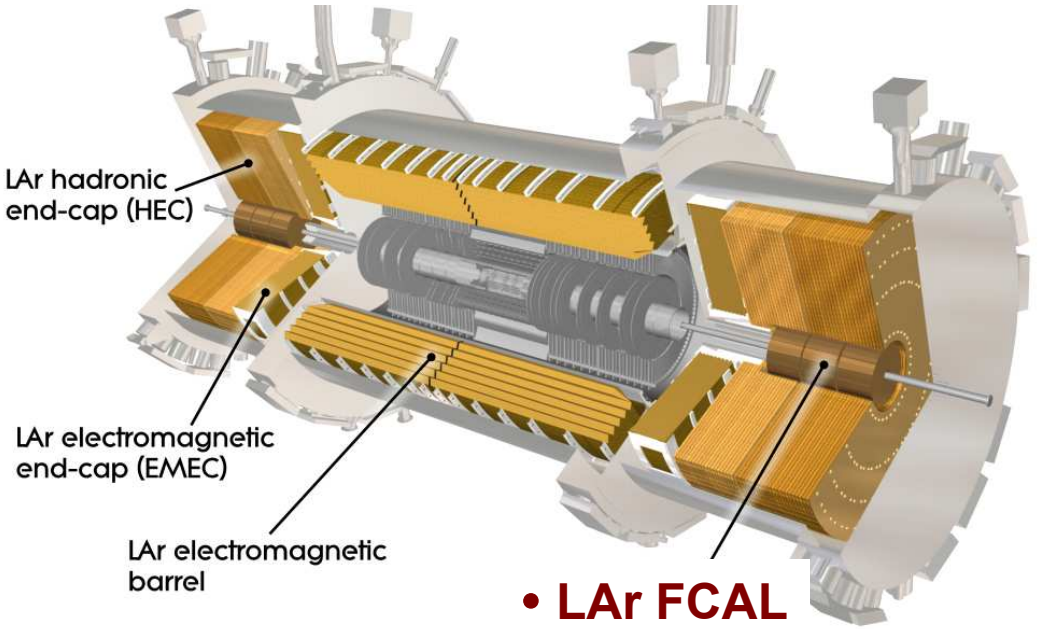
LAr Phase II Upgrade Project

• Readout Electronics



• LAr FCAL

ATLAS LAr Phase II Upgrade:

- Replace the LAr readout electronics
- Modify the forward region, including:
  - possible new (s)FCAL (or miniFCAL)
  - possible new forward precision timing detector

US LAr Institutions

- sFCAL (or LAr MiniFCAL)
  - U Arizona
  - Possible interest from U Iowa
- Frontend Electronics Components
  - BNL, Columbia, U Penn, SMU, UT Dallas
  - Interest from UT Austin
- FEB2 and Frontend System Integration FEB2
  - BNL, Columbia
- Backend Electronics
  - U Arizona, U Oregon, Stony Brook, BNL
  - Interest from MSU
- Timing Detector
  - Interest from UCSC, Oregon, BNL, U Iowa

Some LAr Milestones

- Initial Design Review (IDR)
  - second half of CY 2016

- Technical Design Report (TDR)
  - second half of CY 2017

sFCAL

- For sFCAL, discussion of construction responsibilities is quite advanced, with a collaboration that includes US, Canada, Germany, Russia
- As for original FCAL, U Arizona proposes to produce sFCAL1 modules, and also cold electronics for all sFCAL modules
- Possible interest in involvement from U Iowa, though they are currently focused instead on possible involvement with timing detector
- Construction responsibilities not yet discussed in case (much cheaper) MiniFCAL option is adopted, but U Arizona would be involved in case of LAr MiniFCAL
- sFCAL vs MiniFCAL decision milestone now listed (in SD) as “mid-2016”

(s/Mini)FCAL Core Costs (from SD)

Table 19. CORE costs for the LAr Calorimeter upgrades in the forward region. Costs for a MiniFCal are only due if a high-granularity sFCal will not be implemented and only under well-defined conditions (see Sec. V.4.4).

WBS ID	Upgrade Item	Reference [kCHF]	Medium [kCHF]	Low [kCHF]
3.2	**High-granularity sFCal**	**10,033**		
3.2.1	sFCal1	1,381		
3.2.2	sFCal2	2,567		
3.2.3	sFCal3	2,480		
3.2.4	Cold cable harnesses	995		
3.2.5	Plug	115		
3.2.6	Cooling loops	28		
3.2.7	Cryostat modification	399		
3.2.8	Structural tube, cone, bulkhead	118		
3.2.9	Feedthroughs and signal cables	778		
3.2.10	Front-end and back-end electronics	771		
3.2.11	Detector support and tooling	402		
3.4	**LAr/Cu MiniFCal**			**907**
3.4.1	Detector and Cryostat			125
3.4.2	Warm tube, Moderator, Insertion			330
3.4.3	Electronics and HVPS			285
3.4.4	Module 0			167
3.5	**Si/Cu MiniFCal**			**3,573**
3.5.1	Cu absorbers			30
3.5.2	Sensors and on-detector electronics			1,001
3.5.3	Front-end readout			713
3.5.4	Back-end readout			1750
3.5.5	Services			80

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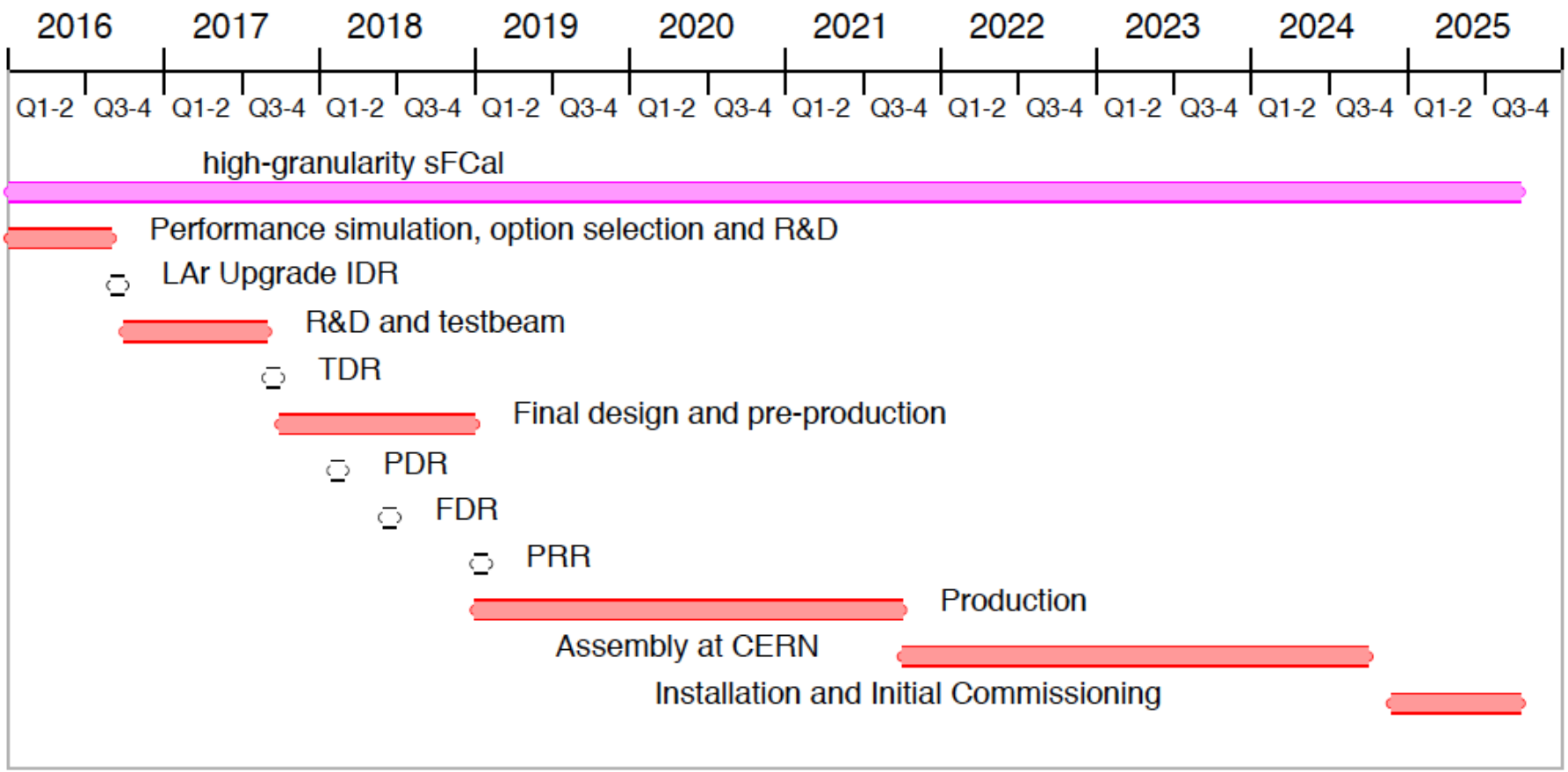
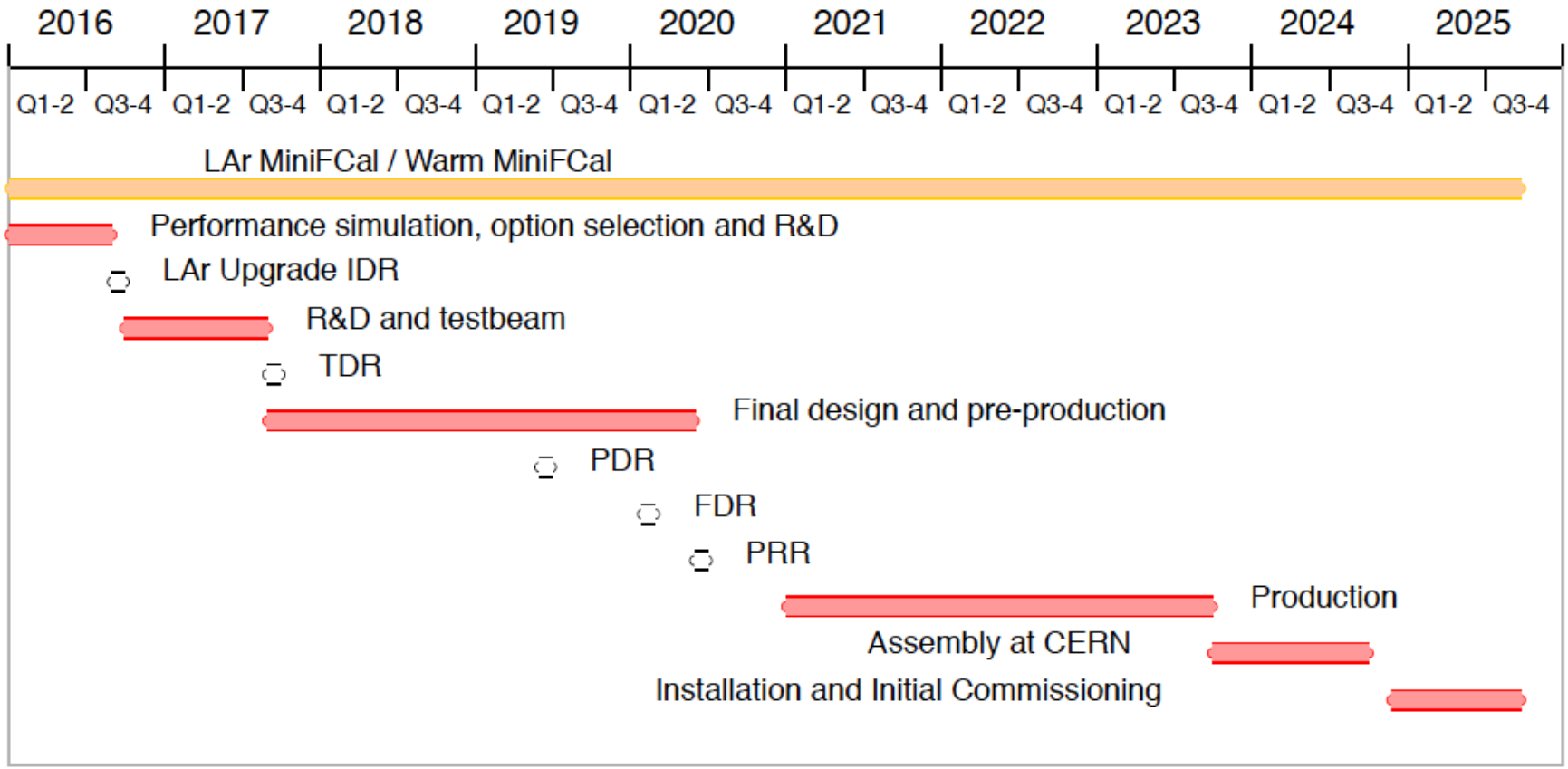
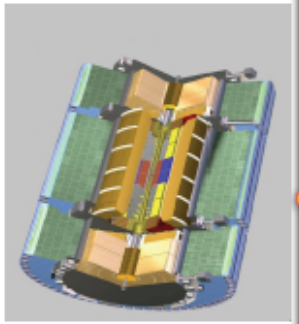
sFCAL Schedule (from SD)

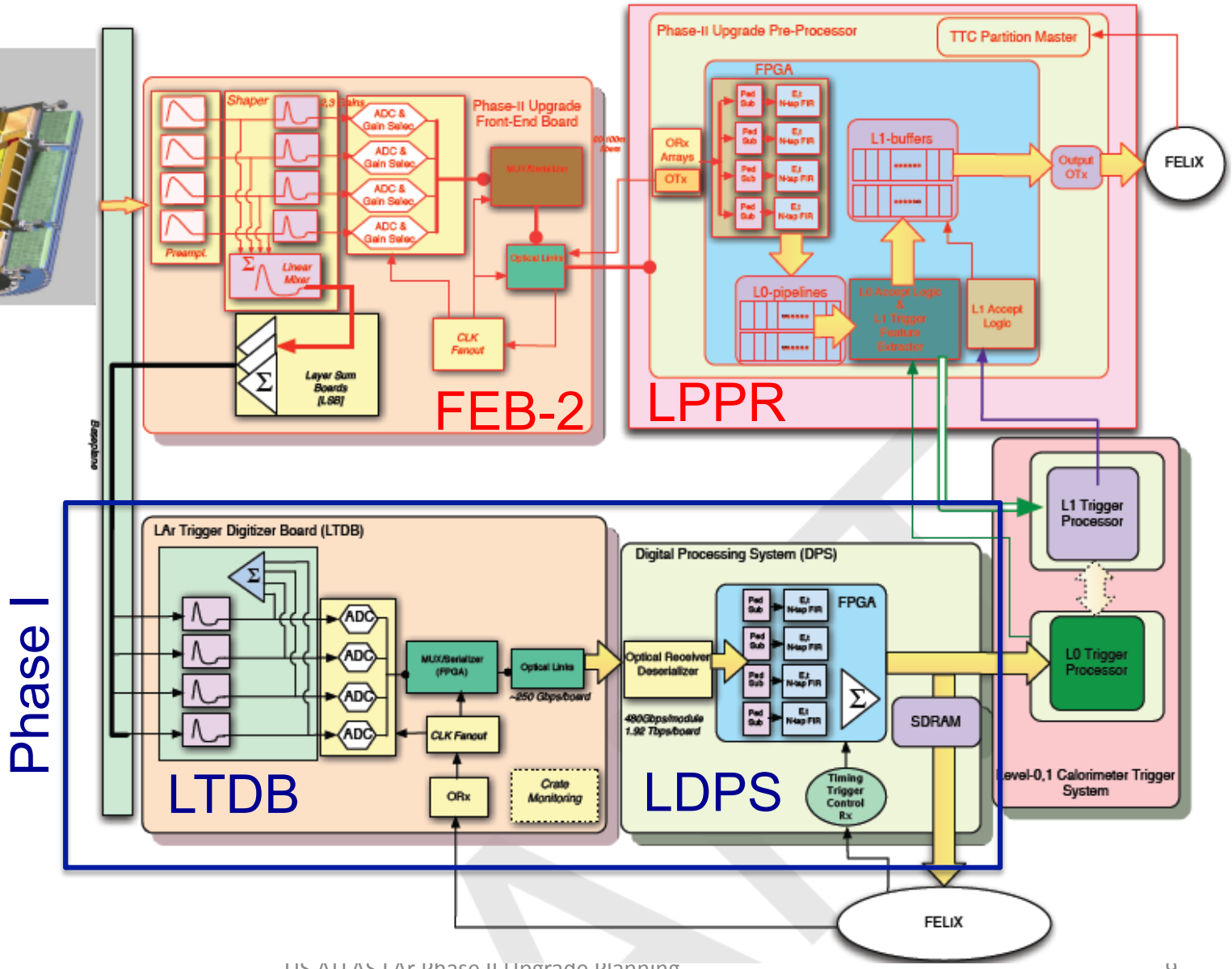


MiniFCAL Schedule (from SD)



Phase II LAr Readout Architecture





LAr Electronics

- As in original construction, US groups proposing to take lead responsibility for LAr FE electronics, with deliverables including:
  - Rad-tol ASICs (preamp/shaper, ADC, serializer)
  - Optical link components
  - FEB 2

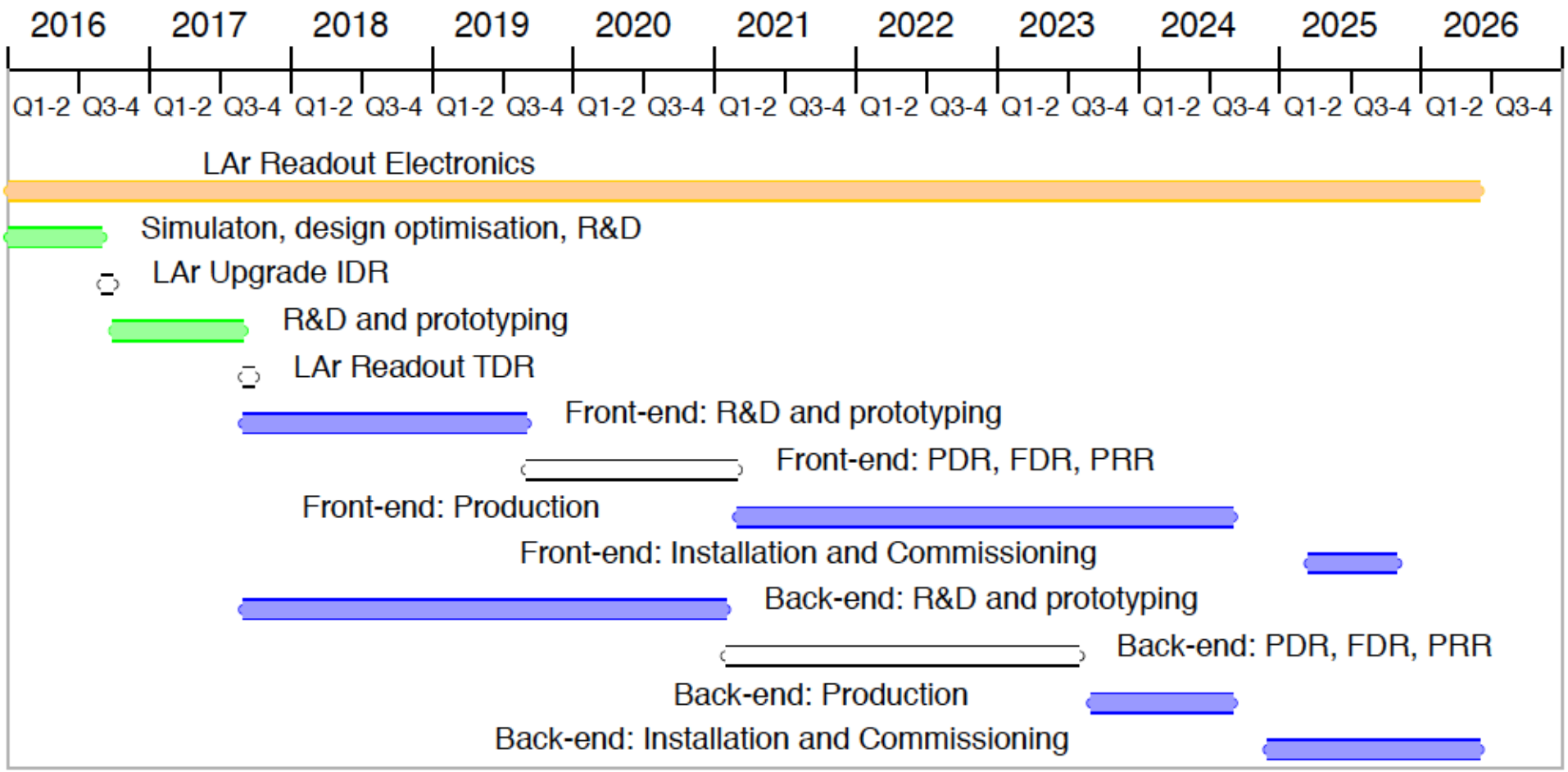
- BE construction responsibilities for Phase II are so far less advanced than for FE
  - Current RODs were built by European collaborators, and considerable interest exists there for a similar role for the LPPR in Phase II
  - US groups are playing significant roles in Phase I LDPS, and will bring this expertise to development of BE electronics for Phase II
  - It is going to take some significant time to sort out and define the US role and deliverables, complicating the planning exercise that we need to go through now
  - BE electronics not included in US cost/manpower estimates made in 2014, so need to start new effort here
  - Propose next step is to hold dedicated mtg with interested US groups in September

LAr Electronics Core Costs (from SD)

Table 16. CORE costs for the new LAr Calorimeter readout. *(Comment: LPPR and FELIX/TTC costs still in review.)*

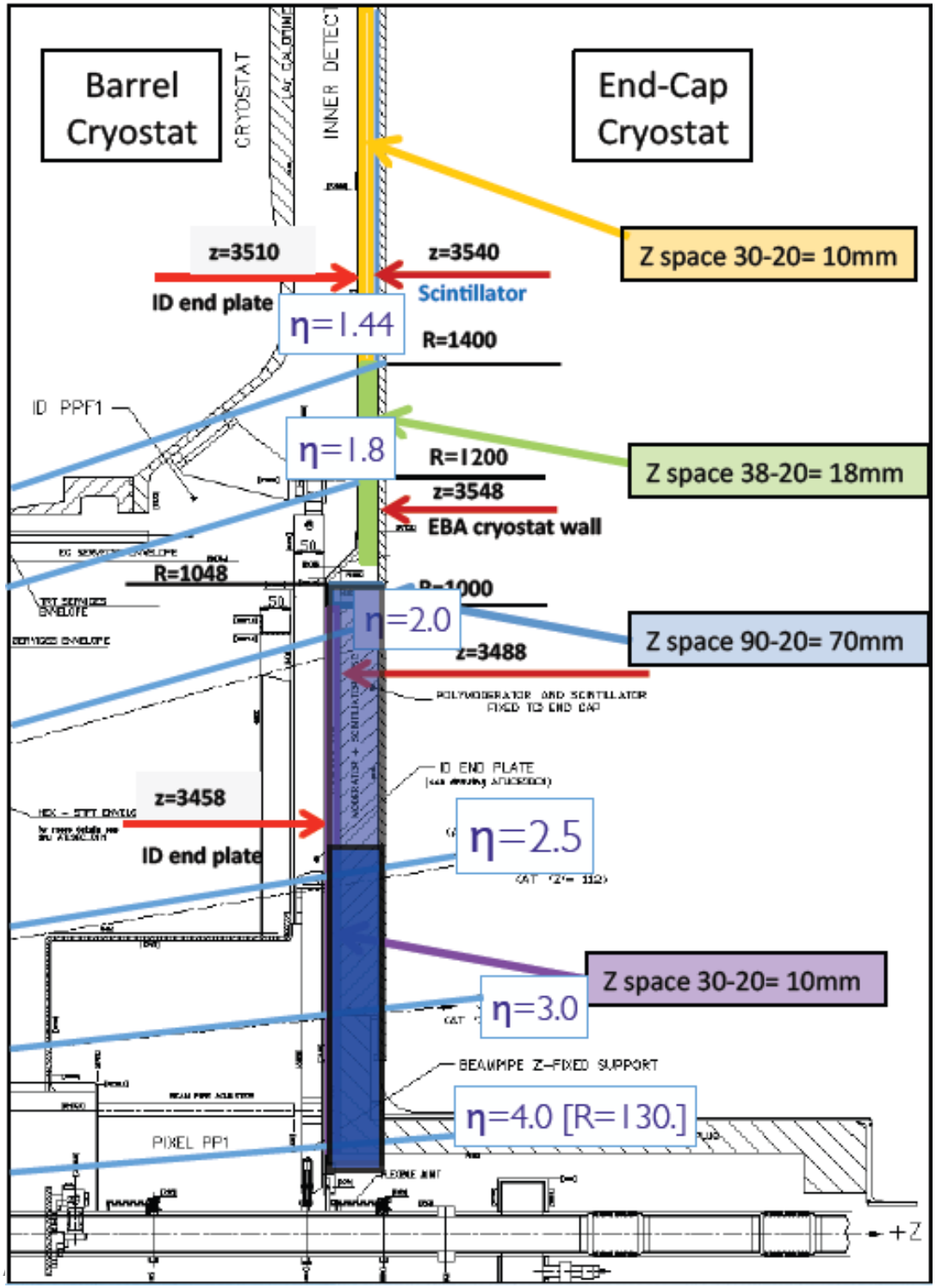
WBS ID	Upgrade Item	All Cost Scenarios [kCHF]
3.1	**LAr Readout Electronics**	**31,394**
3.1.1	**LAr Front-end Electronics**	**20,427**
3.1.1.1	Front-end Boards (FEB-2)	9,743
3.1.1.2	Optical fibres and fibre plant	4,306
3.1.1.3	Front-end power distribution system	3,123
3.1.1.4	HEC LVPS	622
3.1.1.5	Calibration System	2,484
3.1.1.6	Shipping and Logistics	150
3.1.2	**LAr Back-end Electronics**	**10,967**
3.1.2.1	LAr Pre-processor Boards (LPPR)	10,212
3.1.2.2	Transition modules	122
3.1.2.3	ATCA shelves	66
3.1.2.4	ATCA switches	76
3.1.2.5	Server PC	22
3.1.2.6	Controller PC	8
3.1.2.7	FELIX/TTC System	460

LAr Electronics Schedule (from SD)



HGTD

- Scoping Document includes possible new “4D” detector in space of current MTBS
  - Δz = 60 mm detector could cover η of 2.4 – 4.1 (5.0)
- Aiming for time res’n of 30-50 ps and spatial granularity of 1-100 mm^2
- Possibly multiple layers, if also used as preshower
- Synergy with possible Si/Cu miniFCAL (and also CMS)
- More MC studies needed to optimize design and evaluate ability to use timing to reject pileup, select PV, …



HGTD Core Costs (from SD)

Table 20. CORE costs for a High-Granularity Timing Detector in the Reference cost scenario. No Timing Detector is being planned at this stage for the Medium and Low cost scenarios.

WBS ID	Upgrade Item	Reference [kCHF]
3.3	**HGTD**	**4,558**
3.3.1	Sensors and on-detector active electronics	1,921
3.3.2	Front-end readout	1,988
3.3.3	Back-end readout	450
3.3.4	Services	200

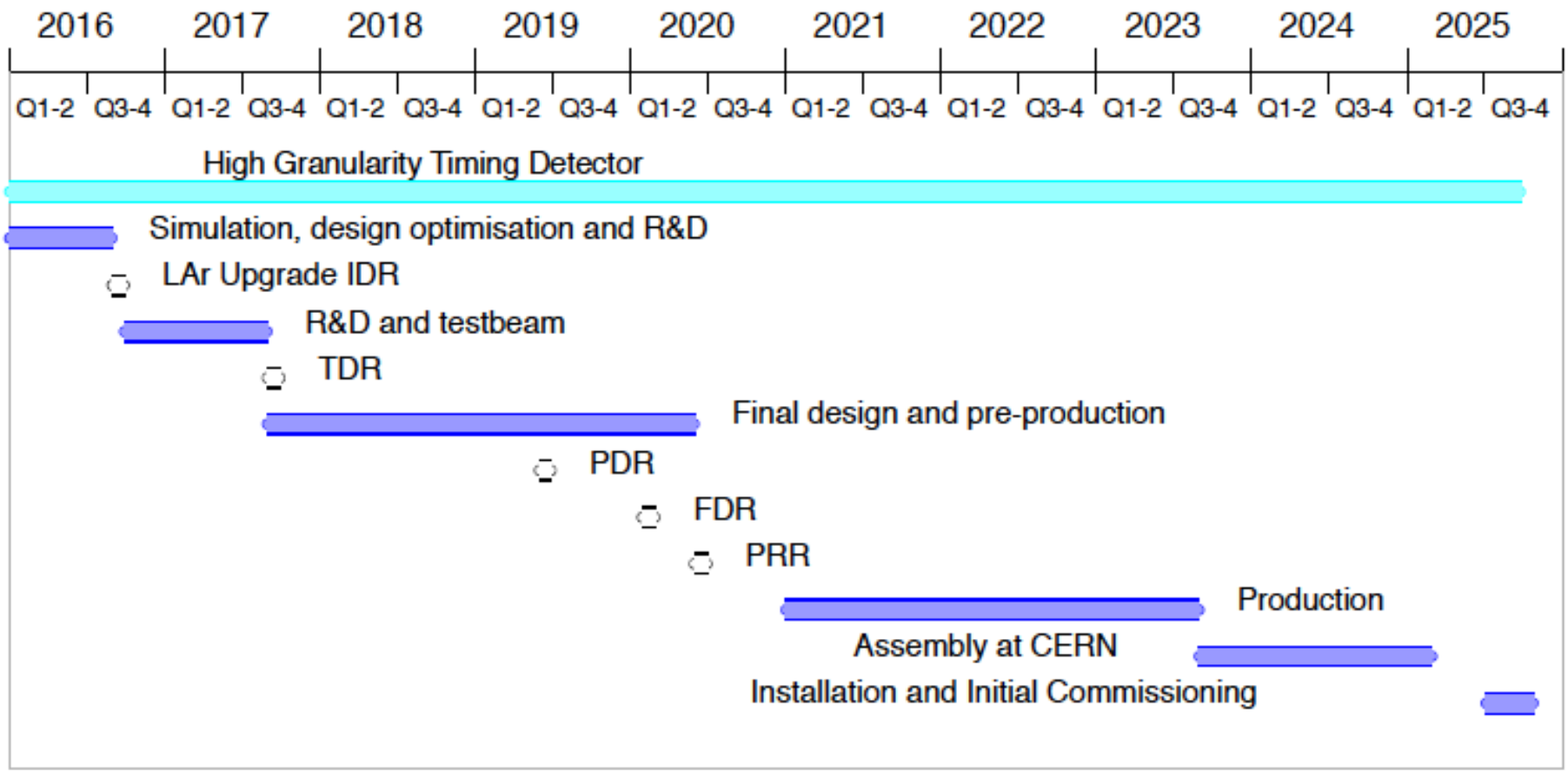
- F. Lanni has promised to provide more info about the HGTD CORE cost estimate (once the pressure to deliver the SD is completed)

Possible US Contributions to HGTD

- UC Santa Cruz proposing technology based on fast Si detectors
  - Possible involvement in this case would include production of 30% of the sensors, plus production/testing of a significant fraction of the detector assemblies
  - Early cost estimate would be ~ $1.1M, including $650k for M&S

- Possible roles of other US groups not further discussed yet

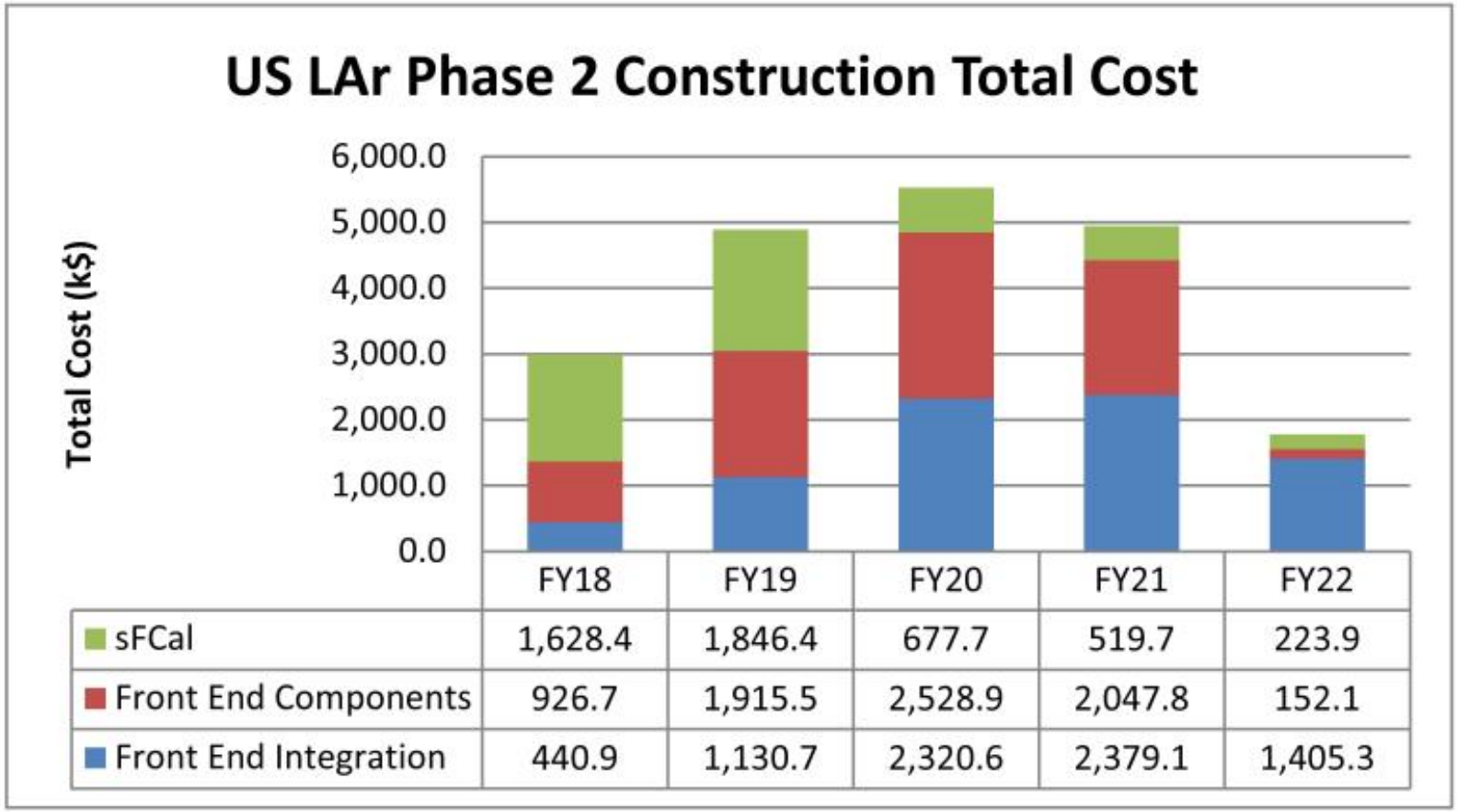
HGTD Schedule (from SD)



Status/Issues for US Planning

- Cost estimate prepared in July 2014 includes only sFCAL and FE electronics
  - Working to update these and adapt to new WBS + schedule
- sFCAL cost and manpower estimates should be fairly solid, since known technology
- FE electronics estimates are much more uncertain, with a strong dependence on technology and option choices which are still be made, including:
  - Large-scale production costs for 65 nm ASICs
  - Final mapping of functionality onto ASICs (ie. level of integration that can be achieved)
- There is also considerable US interest and expertise in the BE electronics, though not included in previous US planning exercise. Discussions concerning BE responsibilities are less advanced so far.
- A few US institutes have expressed interest in HGTD, also not included in previous US planning.

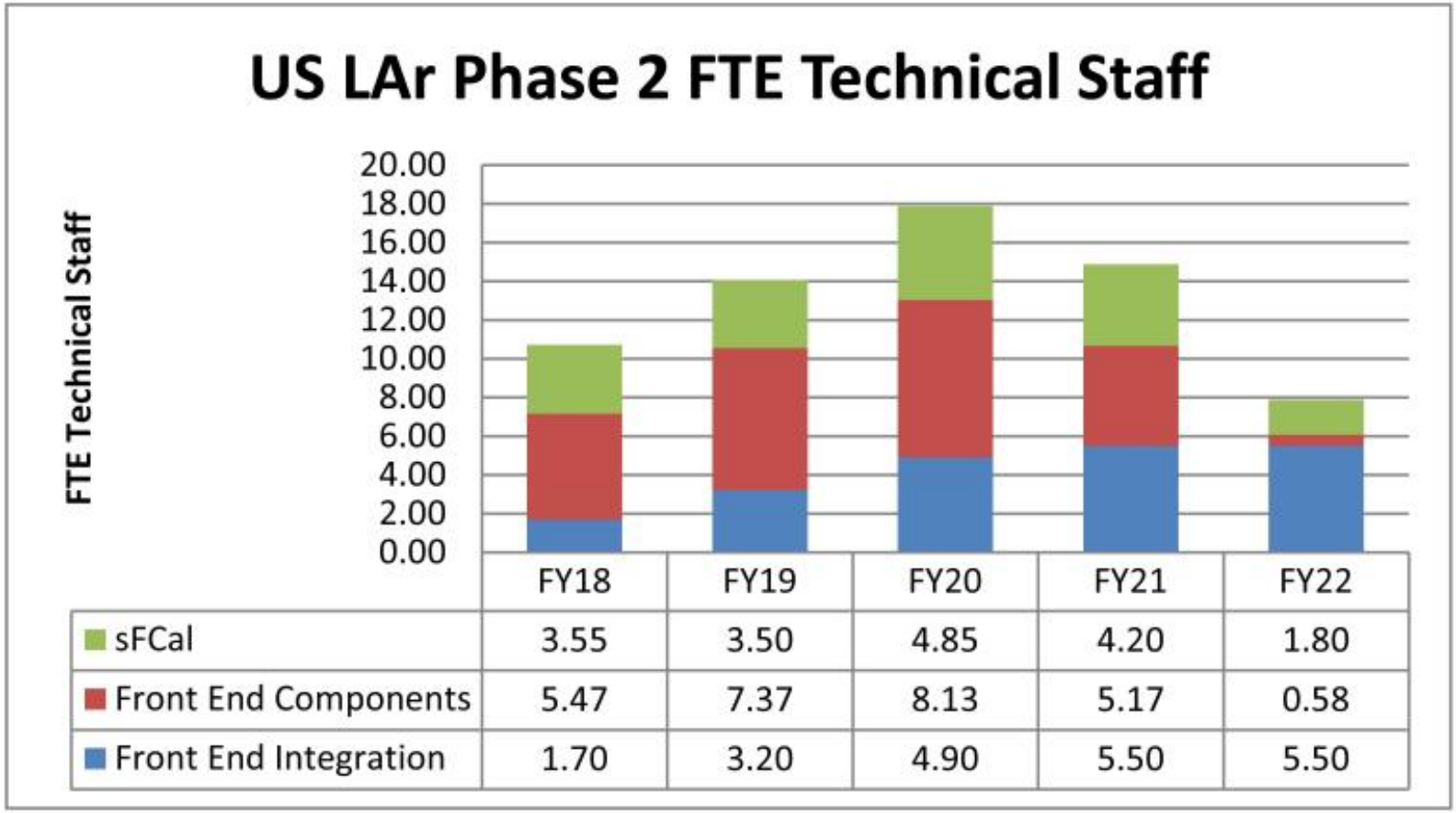
From July 2014 Planning Exercise



	FY18	FY19	FY20	FY21	FY22
sFCal	1,628.4	1,846.4	677.7	519.7	223.9
Front End Components	926.7	1,915.5	2,528.9	2,047.8	152.1
Front End Integration	440.9	1,130.7	2,320.6	2,379.1	1,405.3

Item	Cost (k$)
sFCal	4,896
Front End Components	7,571
Front End Integration	7,677
Total	**20,144**

From July 2014 Planning Exercise



	FY18	FY19	FY20	FY21	FY22
sFCal	3.55	3.50	4.85	4.20	1.80
Front End Components	5.47	7.37	8.13	5.17	0.58
Front End Integration	1.70	3.20	4.90	5.50	5.50

Item	Tech FTE
sFCal	17.9
Front End Components	26.7
Front End Integration	20.8
Total	**65.4**

Summary

- US ATLAS is playing many critical roles in ongoing LAr Phase II planning
- FCAL upgrade option will be finalized around mid-2016 (delayed again in SD). US plans to contribute in either sFCAL or LAr MiniFCAL scenarios
- Readout upgrade concentrates on FEB2 and US is leading the efforts. Current R&D centered on FE components and options that will influence the system integration. Decisions in the R&D course will guide the efforts to construction.
- There is also considerable US interest and expertise in the BE electronics. Discussions concerning BE responsibilities are less advanced so far.
- A few US institutes have expressed interest in HGTD, should it be adopted.

Backup Slides

Phase II TDAQ Architecture